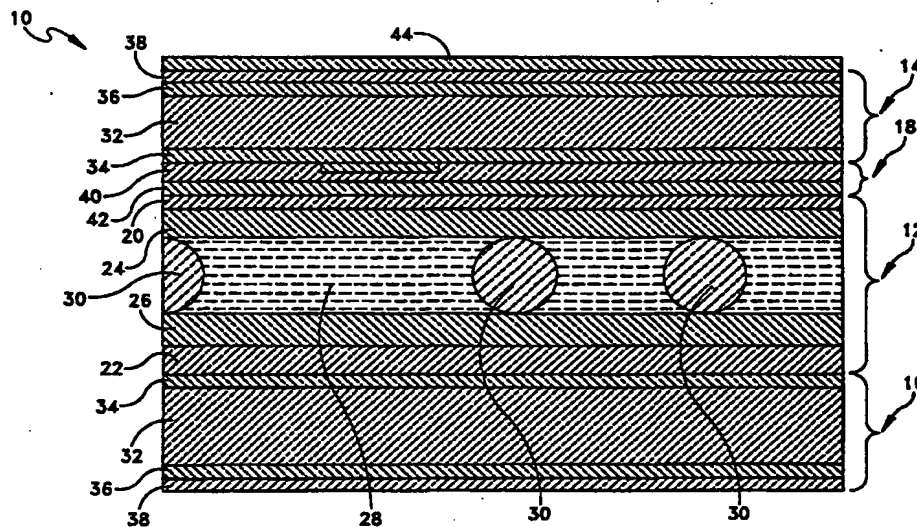


PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶: G02F 1/1333, 1/136	A1	(11) International Publication Number: WO 96/35139 (43) International Publication Date: 7 November 1996 (07.11.96)
(21) International Application Number: PCT/US96/06218 (22) International Filing Date: 3 May 1996 (03.05.96) (30) Priority Data: 435,207 5 May 1995 (05.05.95) US (71) Applicant: SPECIALTY COATING SYSTEMS, INC. [US/US]; 5707 West Minnesota Street, Indianapolis, IN 46241 (US). (72) Inventors: OLSON, Roger, A.; 313 George Street, Amery, WI 54001 (US). WARY, John; 119 Cherokee Lane, Noblesville, IN 46060 (US). (74) Agents: HOLMES, Stephen, J. et al.; Salter & Michaelson, 321 South Main Street, Providence, RI 02903 (US).		(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>With amended claims.</i>

(54) Title: FLAT PANEL DISPLAY WITH PARYLENE BARRIER AND PROTECTIVE FILMS**(57) Abstract**

An improved flat panel display (10) is provided by replacing the various barrier films of the layered construction with thin films of polyparaxylylene (parylene). Parylene is highly transparent and provides superior chemical and electrical properties to the conventional materials used for such barrier films. In the liquid crystal panel assembly (12), the orientation films (24, 26), gate insulator (50) and etch stop layer (56) each comprise a parylene material. In the color filter (18), the color filter overcoat (42) comprises a parylene material. In the substrates (14, 16), the inner and outer barrier films (34, 36) each comprise a parylene material. The flat panel (10) is further provided with an external protective overcoat (44) comprising a parylene material. The protective overcoat (44) is believed to enhance light transmission through the panel assembly thereby increasing the brightness of the display panel.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

1 **FLAT PANEL DISPLAY WITH PARYLENE BARRIER AND PROTECTIVE**
2 **FILMS**

3 **Background and Summary of the Invention:**

4 The instant invention relates to flat panel
5 displays, and more particularly to the use of
6 polyparaxylylene (parylene) as dielectric and/or barrier
7 layers in passive and active matrix flat panel displays.

8 Flat panel displays have heretofore been known in
9 the art. In this regard, a conventional flat panel
10 display typically includes a plurality of component
11 layers, such as a liquid crystal panel assembly, glass
12 substrates, a color filter, etc.. Within each of the
13 component layers are various transparent barrier layers
14 which separate and insulate the various component layers
15 of the display. In some cases, the barrier layers are
16 required to function as electrical insulators. Typically,
17 the industry utilizes materials such as SiO_2 , polyimide,
18 acrylic, urethane and SiN to form the various barrier
19 layers in flat panel displays. However, there are
20 numerous problems associated with each of these materials
21 and the techniques used to apply them, including high
22 cost, non-uniform application, material waste in
23 application methods, and poor transparency.

24 The instant invention provides an improved flat
25 panel display wherein the various barrier, and protective
26 films of the layered construction comprise thin films of

1 a polyparaxylylene (parylene) material. Parylene is a
2 versatile, inert transparent polymer which can be applied
3 in thin film conformal coatings by a vacuum deposition
4 process. Parylene provides a highly transparent, thin
5 film barrier layer having a highly uniform coating
6 thickness. Parylene further has attractive dielectric
7 properties so that it functions as an excellent
8 electrical insulator. The flat panel display comprises
9 a liquid crystal panel assembly, first and second
10 substrates positioned on opposing sides of the liquid
11 crystal panel and a color filter disposed between the
12 first substrate and the liquid crystal panel. The liquid
13 crystal panel includes first and second electrode members
14 each having an orientation film disposed on an inwardly
15 facing surface thereof, a gate insulator adjacent the
16 second electrode member, and a plurality of thin film
17 transistors on the second electrode member. In the liquid
18 crystal panel assembly, the orientation films, gate
19 insulator and etch stop layer of the thin film transistor
20 each comprise a parylene material. The color filter
21 comprises a color filter layer and a color filter
22 overcoat comprising a parylene material. The substrates
23 comprise a glass panel, and inner and outer barrier films
24 each comprising a parylene material. The flat panel is
25 further provided with an external protective overcoat
26 comprising a parylene material. The protective overcoat

1 is believed to enhance light transmission through the
2 panel assembly thereby increasing the brightness of the
3 display panel.

4 Accordingly, among the objects of the instant
5 invention are the provision of a flat panel display
6 wherein the inner and outer barrier films of the glass
7 substrate comprises parylene; the provision of a flat
8 panel display wherein the gate insulator and etch stop
9 layer of the liquid crystal panel assembly comprise a
10 parylene material; the provision of a flat panel display
11 wherein an orientation film comprises a parylene
12 material; the provision of a flat panel display wherein
13 a color filter overcoat layer comprises a parylene
14 material; and the provision of a flat panel display
15 wherein an external coating comprises a parylene
16 material.

17 Other objects, features and advantages of the
18 invention shall become apparent as the description
19 thereof proceeds when considered in connection with the
20 accompanying illustrative drawings.

21

22 Description of the Drawings:

23 In the drawings which illustrate the best mode
24 presently contemplated for carrying out the present
25 invention:

1 Fig. 1 is a cross-sectional view of a passive flat
2 panel display in accordance with the instant invention;

3 Fig. 2 is a cross-sectional view of an active matrix
4 color flat panel display in accordance with the instant
5 invention; and

6 Fig. 3 is an enlarged cross-sectional view of a thin
7 film transistor of the display panel of Fig. 2.

8

9 **Description of the Preferred Embodiment:**

10 Referring now to the drawings, a passive flat panel
11 display assembly in accordance with the instant invention
12 is illustrated and generally indicated at 10 in Fig. 1.
13 As will hereinafter be more fully described, the instant
14 flat panel display 10 includes a plurality of dielectric
15 and barrier layers which comprise a polyparaxylylene
16 material. Polyparaxylylene is a highly transparent
17 polymer composition which provides superior chemical and
18 electrical properties to the conventional materials used
19 for various barrier films and dielectric layers.
20 Polyparaxylylene (parylene) is commercially available
21 from Alpha Metals, Inc. and is sold in various
22 formulations including "Parylene N", "Parylene C" and
23 "Parylene D" having the following formulas.

1

2

3

4

5

6

7

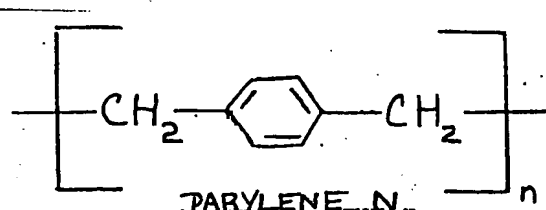
8

9

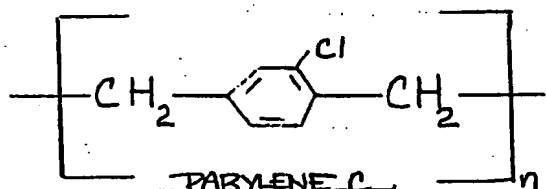
10

11

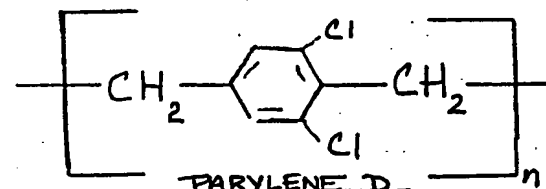
12



PARYLENE N



PARYLENE C



PARYLENE D

13 Parylene is also available in numerous of other
 14 variations, including a fluorinated parylenes. Any one of
 15 described parylene formulations, or any other derivative
 16 thereof, is suitable for use in the instant invention.
 17 Accordingly, for purposes of this specification, the term
 18 "parylene" is intended to means polyparaxylylene or any
 19 one of its derivative forms.

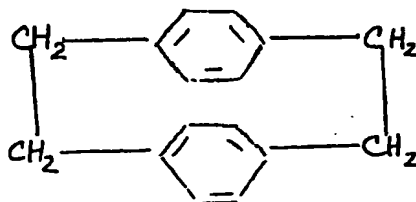
20 Parylene is typically deposited in a thin film onto
 21 a substrate using a vacuum vapor deposition method
 22 wherein a parylene dimer of the formula:

23

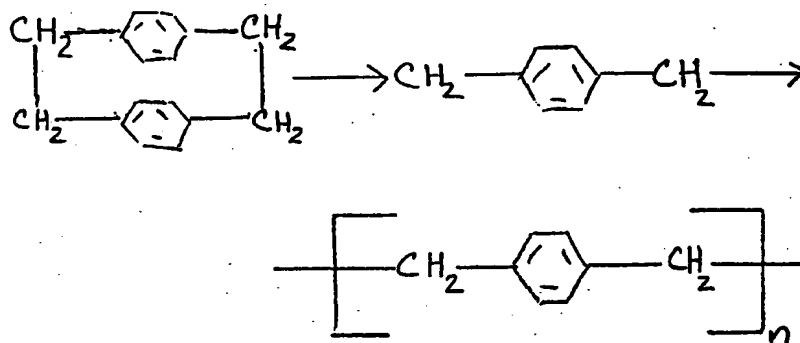
24

25

26



1 is split into its monomer form according to the following
 2 reaction:



12 Briefly, a powdered form of the parylene dimer is
 13 vaporized in a vaporization chamber, and then the
 14 vaporized dimer is split into its monomer form in a
 15 pyrolysis chamber. The monomer vapor is then fed into a
 16 vacuum chamber in which a substrate to be coated is
 17 located. The parylene vapor then settles onto the
 18 substrate in a very even, conformal coating. Various
 19 thicknesses of coating can be achieved by known means. In
 20 any event, the parylene coating processes are well known
 21 in the art, and will not be described further.

22 Referring again to Fig. 1, the flat panel display
 23 assembly 10 comprises a liquid crystal panel assembly
 24 generally indicated at 12, first and second transparent
 25 substrates generally indicated at 14, 16 and respectively

1 positioned on opposing sides of said liquid crystal panel
2 12, and a color filter generally indicated at 18.

3 The liquid crystal panel 12 comprises first and
4 second transparent electrode members 20, 22 each having
5 an orientation film 24, 26 disposed on inwardly facing
6 surfaces thereof. The transparent electrode members 20,
7 22 preferably comprise indium tin oxide, and the
8 orientation films 24, 26 preferably comprise a parylene
9 material. The liquid crystal panel 12 further comprises
10 a liquid crystal material 28, such as a noematic liquid
11 crystal composition, received between the first and
12 second electrode members 20, 22. The liquid crystal
13 material 28 is provided with plastic or glass spheres 30,
14 or spacers, which serve to space apart the electrodes.
15 The liquid crystal panel 12 is operative in a
16 conventional manner wherein the parylene orientation
17 films 24, 26 facilitate alignment of the crystals when an
18 electric field is generated in the liquid crystal panel
19 12.

20 Each of the transparent substrates 14, 16 comprises
21 a flat glass panel 32, inner and outer barrier films 34,
22 36 respectively disposed on inner and outer surfaces of
23 the glass panel 32, and a polarizing film 38 disposed on
24 an outer surface of the outer barrier film 36. The inner
25 and outer barrier films 34, 36 comprise a parylene
26 material.

1 The color filter 18 comprises a color filter layer
2 40, and a color filter overcoat 42. The color filter
3 layer 40 is conventional in the art, and is fashioned by
4 known dyeing, printing or electrodeposition methods. The
5 color filter overcoat 42 comprises a parylene material.

6 The flat panel display 10 is further provided with
7 a protective overcoat 44 applied on the outer surface of
8 the polarizing film 38 of the first substrate assembly
9 14. The protective overcoat 44 provides a protective
10 coating to the flat panel display 10. However, the
11 coating 44 has also been found to provide an unexpected
12 function of increasing light transmission through the
13 panel. It is estimated that up to 20% more light is
14 transmitted through the panel assembly 10 due to the
15 external parylene coating 44. This light enhancing effect
16 is primarily due to a symmetrical alignment of the
17 parylene molecules in the coating 44 which effectively
18 act as light concentrators, drawing in light from a wide
19 area and focusing that light into the flat panel. The
20 overall effect is a brighter, more vivid screen display,
21 which can be achieved with a less powerful light source.

22 Referring now to Fig. 2, an active matrix flat panel
23 display is generally indicated at 46. The active matrix
24 panel 46 is generally similar to the passive matrix
25 display 10 with the exception of a plurality of thin film
26 transistors generally indicated at 48, and a gate

1 insulator 50. Referring to Figs. 2 and 3, the thin film
2 transistors 48 comprise a gate metal layer 52, comprising
3 a metal such as Cr, Ti, W, Mo, Al or Ta, an OHMIC contact
4 54, an etch stop layer 56, and a source/drain metal layer
5 58. The etch stop layer 56 of the thin film transistor
6 is formed from a parylene material. Furthermore, the gate
7 insulator 50 also comprises a parylene material.
8 Construction of the thin film transistors is otherwise
9 conventional and known in the art.

10 It can therefore be seen that the instant invention
11 provides novel and effective flat panel display
12 assemblies 10, 46 which are less expensive to produce,
13 and which has a better transparency than the prior art
14 flat panels. The various parylene layers of the flat
15 panel displays provide highly transparent, conformal
16 layers in the panels which effectively transmit light,
17 while offering superior electrical and chemical
18 properties than the prior art materials. For these
19 reasons, the instant invention is believed to represent
20 a significant advancement in the art which has
21 substantial commercial merit.

22 While there is shown and described herein certain
23 specific structure embodying the invention, it will be
24 manifest to those skilled in the art that various
25 modifications and rearrangements of the parts may be made
26 without departing from the spirit and scope of the

1 underlying inventive concept and that the same is not
2 limited to the particular forms herein shown and
3 described except insofar as indicated by the scope of the
4 appended claims.

Claims:

1 1. A flat panel display comprising a liquid crystal
2 panel, and first and second transparent substrates
3 positioned on opposing sides of said liquid crystal
4 panel, said liquid crystal panel comprising first and
5 second transparent electrode members each having an
6 orientation film disposed on inwardly facing surfaces
7 thereof, said liquid crystal panel further comprising a
8 liquid crystal material received between said first and
9 second electrode members, each of said transparent
10 substrates comprising a glass panel, inner and outer
11 barrier films disposed on inner and outer surfaces of
12 said glass panel, and a polarizing film disposed on an
13 outer surface of said outer barrier film.

1 2. In the flat panel display of claim 1, said inner and
2 outer barrier films comprising a parylene material.

1 3. The flat panel display of claim 1 further comprising
2 a protective overcoat disposed on an outer surface of a
3 polarizing film of one of said transparent substrates,
4 said protective overcoat comprising a parylene material.

1 4. A transparent substrate for use in a flat panel
2 display comprising a glass panel, inner and outer barrier
3 films disposed on inner and surfaces of said glass panel,

4 and a polarizing film disposed on an outer surface of
5 said outer barrier film, said inner and outer barrier
6 films comprising a parylene material.

1 5. The transparent substrate of claim 4, further
2 comprising a protective overcoat disposed on an outer
3 surface of said polarizing film, said protective overcoat
4 comprising a parylene material.

1 6. An active matrix flat panel display comprising an
2 active matrix liquid crystal panel, first and second
3 transparent substrates positioned on opposing sides of
4 said liquid crystal panel, and a color filter panel
5 positioned between said liquid crystal panel and said
6 first substrate, said liquid crystal panel comprising
7 first and second transparent electrode members each
8 having an orientation film disposed on inwardly facing
9 surfaces thereof, said liquid crystal panel further
10 comprising a liquid crystal material received between
11 said first and second electrode members, said liquid
12 crystal panel still further comprising a plurality of
13 thin film transistors disposed on said second electrode
14 member, and a gate insulator disposed on an outwardly
15 facing surface of said second electrode member, each of
16 said transparent substrates comprising a glass panel,
17 inner and outer barrier films disposed on inner and outer

18 surfaces of said glass panel, and a polarizing film
19 disposed on an outer surface of said outer barrier film.

1 7. In the flat panel display of claim 6, said gate
2 insulator comprising a parylene material.

1 8. In the flat panel display of claim 6, said thin film
2 transistors each having an etch stop layer, said etch
3 stop layer comprising a parylene material.

1 9. In the flat panel display of claim 7, said thin film
2 transistors each having an etch stop layer, said etch
3 stop layer comprising a parylene material.

1 10. In the flat panel display of claim 7, said
2 orientation films comprising a parylene material.

1 11. In the flat panel display of claim 9, said
2 orientation films comprising a parylene material.

1 12. In the flat panel display of claim 6, said color
2 filter overcoat comprising a parylene material.

1 13. In the flat panel display of claim 6, said inner and
2 outer barrier films of each of said substrates comprising
3 a parylene material.

1 14. The flat panel display of claim 6 further comprising
2 a protective overcoat disposed on an outer surface of a
3 polarizing film of one of said transparent substrates,
4 said protective overcoat comprising a parylene material.

1 15. In the flat panel display of claim 6, said
2 orientation films, said gate insulator, said color filter
3 overcoat, and said inner and outer barrier films each
4 comprising a parylene material.

1 16. An active liquid crystal panel for use in a flat
2 panel display comprising:

3 a first and second transparent electrode members
4 each having an orientation film disposed on an inwardly
5 facing surface thereof;

6 a plurality of thin film transistors disposed on
7 said second transparent electrode, each of said thin film
8 transistors comprising an etch stop layer, said etch stop
9 layer comprising a parylene material.

10 a liquid crystal material disposed between said
11 first and second electrode members;

12 a gate insulator disposed on an outer surface of
13 said second electrode member, said gate insulator
14 comprising a parylene material.

1 17. In the liquid crystal panel of claim 16, said
2 orientation layers comprising a parylene material.

1 18. A color filter for use in a flat panel display
2 comprising a color filter layer and a color filter
3 overcoat layer, said color filter overcoat layer
4 comprising a parylene material.

AMENDED CLAIMS

[received by the International Bureau on 10 October 1996 (10.10.96);
original claims 1 and 6 amended; original claims 2 and 7 cancelled;
remaining claims unchanged (2 pages)]

1. A flat panel display comprising a liquid crystal panel, and first and second transparent
5 substrates positioned on opposing sides of said liquid crystal panel, said liquid crystal panel
comprising first and second transparent electrode members each having an orientation film disposed
on inwardly facing surfaces thereof, said liquid crystal panel further comprising a liquid crystal
material received between said first and second electrode members, each of said transparent
substrates comprising a glass panel, inner and outer barrier films disposed on inner and outer
10 surfaces of said glass panel, and a polarizing film disposed on an outer surface of said outer barrier
film, wherein the inner and outer barrier films comprise a parylene material.
3. The flat panel display of claim 1 further comprising a protective overcoat disposed on an
outer surface of a polarizing film of one of said transparent substrates, said protective overcoat
15 comprising a parylene material.
4. A transparent substrate for use in a flat panel display comprising a glass panel, inner and
outer barrier films disposed on inner and surfaces of said glass panel,

surfaces of said glass panel, and a polarizing film disposed on an outer surface of said outer barrier film, wherein said gate insulator comprises a parylene material.

8. In the flat panel display of claim 6, said thin film transistors each having an etch stop layer,
5 said etch stop layer comprising a parylene material.
9. In the flat panel display of claim 7, said thin film transistors each having an etch stop layer,
said etch stop layer comprising a parylene material.
- 10 10. In the flat panel display of claim 7, said orientation films comprising a parylene material.
11. In the flat panel display of claim 9, said orientation films comprising a parylene material.
12. In the flat panel display of claim 6, said color filter overcoat comprising a parylene material.
15
13. In the flat panel display of claim 6, said inner and outer barrier films of each of said
substrates comprising a parylene material.

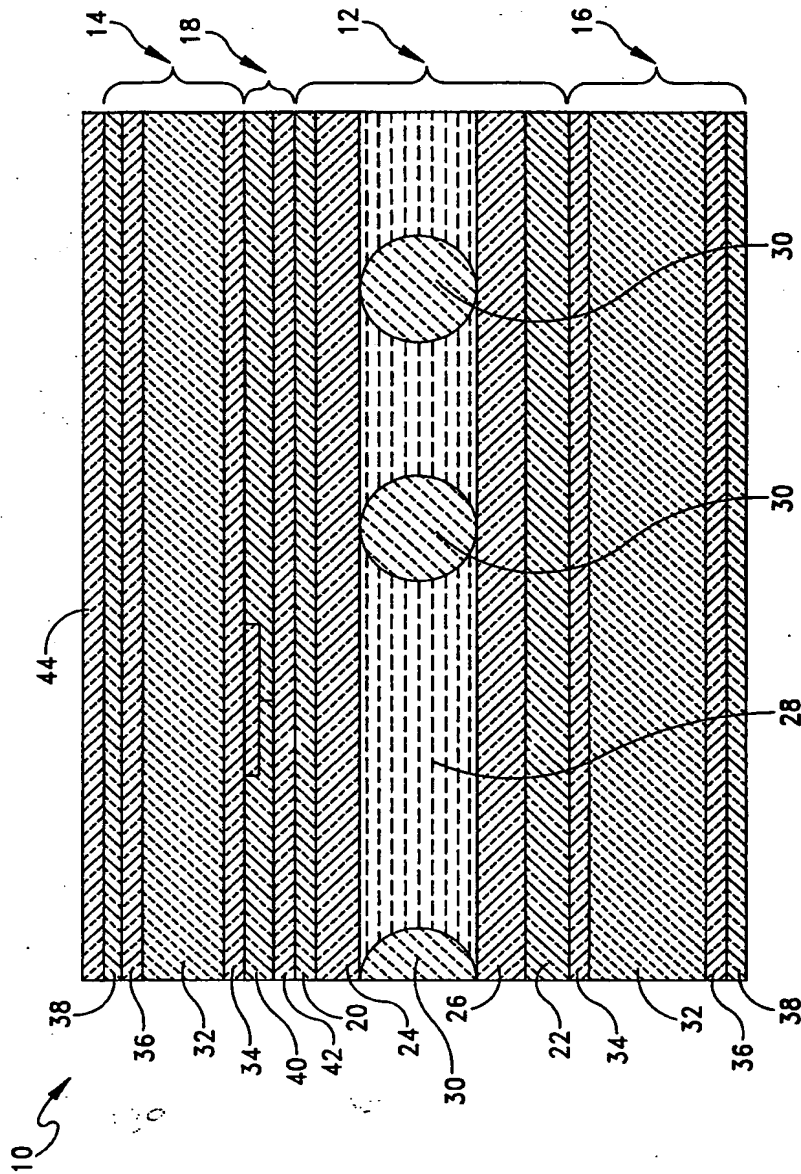


FIG. 1

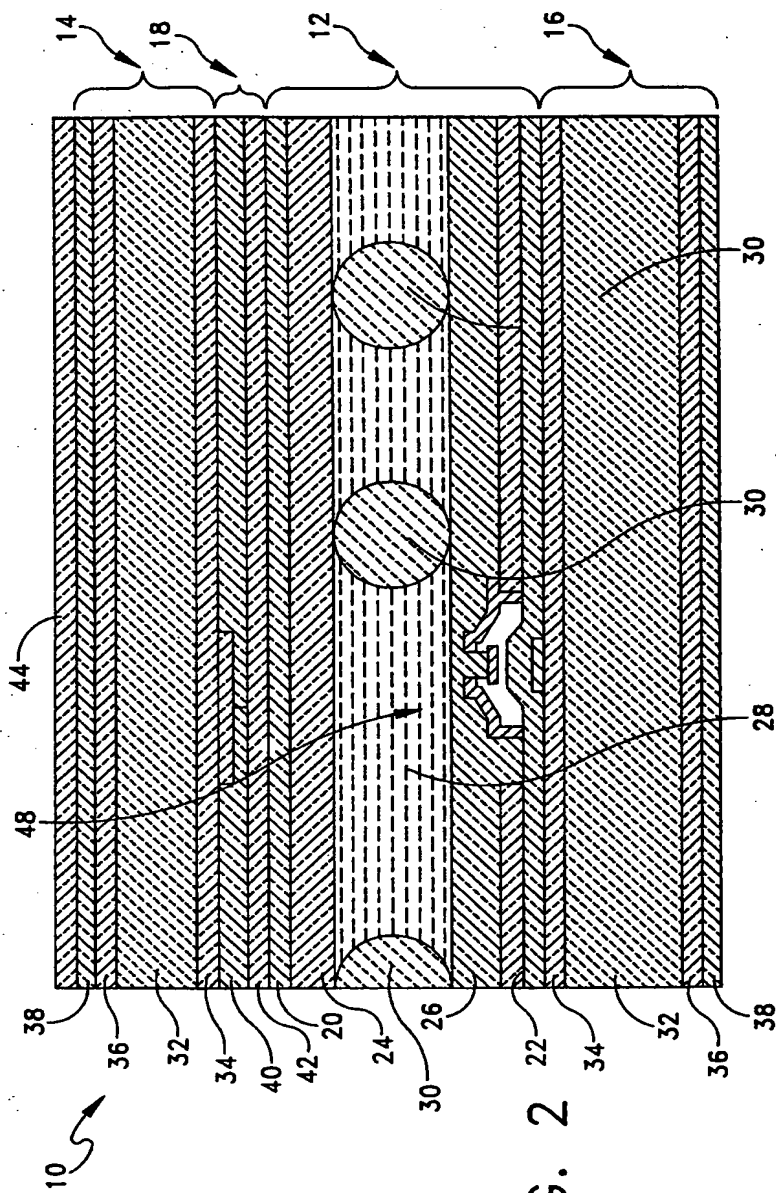


FIG. 2

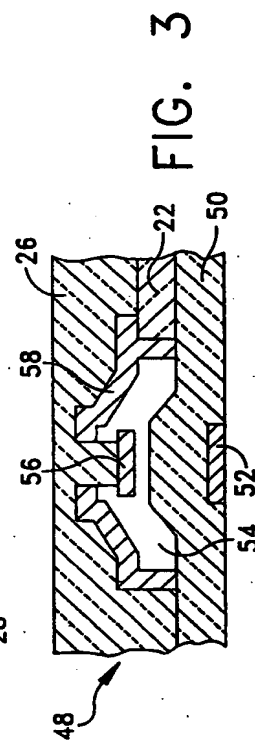


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/06218**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) :G02F 1/1333, 1/136

US CL :359/59, 63, 68, 74, 75, 79, 82

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 359/59, 63, 68, 74, 75, 79, 82

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

USPTO APS "polyxylylene or parylene or poly-para-xylylene", "etch stop", "barrier film", "protective overcoat", "gate insulating", "overcoat", "orientation film", "color filter"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP, A, 0 226 218 (CANON KK) 24 June 1987, page 6, lines 15-31, figure 7.	18
Y		12, 15
Y	US, A, 5,177,475 (STEPHANY ET AL) 05 January 1993, column 10, lines 4-59.	1-17
Y	US, A, 4,425,030 (SCHMIDT) 10 January 1984, column 2, lines 25-47, column 3, line 26 - column 4, line 43.	2-6, 13-15
Y	US, A, 5,245,457 (FUKUCHI) 14 September 1993, column 1, lines 16-50, figure 4.	1-15
Y	US, A, 5,045,753 (KATAYAMA ET AL) 03 September 1991, column 1, line 57 - column 2, line 47, column 6, lines 53-56, column 7, lines 35-42, figure 8B.	6-17

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* "A"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier document published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

29 JULY 1996

Date of mailing of the international search report

14 AUG 1996

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

TAI DUONG

Telephone No. (703) 308-4873

INTERNATIONAL SEARCH REPORTInternational application No.
PCT/US96/06218**C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,064,165 (JERMAN) 12 November 1991, column 9, lines 20-68.	8, 9, 16, 17
Y	JP, A, 53-68098 (ASAHI GLASS KK) 17 June 1978, figure 6, abstract.	1-15
Y	JP, A, 64-37872 (SEIKO EPSON CORP) 08 February 1989, figure 1 element 6, abstract.	7, 15, 16